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ExxonMobil and Georgia Tech Innovation Could Lead to Significant Cuts in Chemical Manufacturing Energy Use and Emissions

- Molecular-level filter could revolutionize energy-intense chemical process
- Significantly reduces amount of energy used in polyester and plastic manufacturing
- Research published in nation's leading peer-reviewed journal, *Science*

IRVING, Texas--(BUSINESS WIRE)-- Scientists from ExxonMobil and the Georgia Institute of Technology have developed a potentially revolutionary new technology that could significantly reduce the amount of energy and emissions associated with manufacturing plastics. Results of the research were published today in the peer-reviewed journal *Science.*

If brought to industrial scale, this breakthrough could reduce industry's global annual carbon dioxide emissions by up to 45 million tons, which is equivalent to the annual energy-related carbon dioxide emissions of about five million U.S. homes. It could also reduce global energy costs used to make plastics by up to $2 billion a year.

Using a molecular-level filter, the new process employs a form of reverse osmosis to separate para-xylene, a chemical building block for polyester and plastics, from complex hydrocarbon mixtures. The current commercial-scale process used around the world relies on energy and heat to separate those molecules.

"Through collaboration with strong academic institutions like Georgia Tech, we are constantly exploring new, more efficient ways to produce the energy, chemicals, and other products consumers around the world rely on every day," said Vijay Swarup, vice president of research and development at ExxonMobil Research and Engineering Company. "If advanced to commercial-scale application, this technology could significantly reduce the amount of greenhouse gas emissions associated with chemical manufacturing."

The research successfully demonstrated that para-xylene can be separated from like chemical compounds known as aromatics by pressing them through a membrane that acts as a high-tech sieve, similar to a filter with microscopic holes. Commercially practiced separations involve energy-intensive crystallization or adsorption with distillation. Globally, the amount of energy used in conventional separation processes for aromatics is equal to about 20 average-sized power plants.

The ExxonMobil and Georgia Tech team first developed a new carbon-based membrane that can separate molecules as small as a nanometer. The membrane was then incorporated into a new organic solvent reverse osmosis process, during which aromatics were pressed through the membrane, separating out para-xylene.

"In effect, we'd be using a filter with microscopic holes to do what an enormous amount of heat and energy currently do in a chemical process similar to that found in oil refining," said Mike Kerby, corporate strategic research manager at ExxonMobil.

The carbon-based membrane developed by the ExxonMobil-Georgia Tech team is about 50 times more energy efficient than the current state-of-the-art membrane separation technology. Because the new membrane is made from a commercially available polymer, ExxonMobil believes it has potential for commercialization and integration into industrial chemical separation processes.

Reverse-osmosis membranes are already widely used to desalinate seawater, consuming a fraction of the energy required by thermally driven processes. The new organic solvent reverse osmosis process is believed to be the first use of reverse osmosis with carbon membranes to separate liquid hydrocarbons.

"By applying pressure at room temperature, the membrane is able to concentrate para-xylene from a mixture at high rates and low energy consumption relative to state-of-the-art membranes," said Ryan Lively, an assistant professor in Georgia Tech's School of Chemical & Biomolecular Engineering and the lead researcher. "This mixture could then be fed into a conventional thermal process for finishing, which would dramatically reduce total energy input."

The technology still faces challenges before it can be considered for commercialization and use at an industrial scale. The membranes used in the process will need to be tested under more challenging conditions, as industrial mixtures normally contain multiple organic compounds and may include materials that can foul membrane systems. The researchers must also learn to make the material consistently and demonstrate that it can withstand long-term industrial use.

"The implications could be enormous in terms of the amount of energy that could be saved and the emissions reduced in chemical and product manufacturing," said Benjamin McCool, an advanced research associate at ExxonMobil and co-author of the research. "Our next steps are to further the fundamental understanding in the lab to help develop a plan for pilot plant-scale demonstration and, if successful, proceed to larger scale. We continue to work the fundamental science underlying this technology for broader applications in hydrocarbon separations."

Chemical plants account for about eight percent of global energy demand and about 15 percent of the projected growth in demand to 2040. As global populations and living standards continue to rise, demand for auto parts, housing materials, electronics and other products made from plastics and other petrochemicals will continue to grow. Improving industrial efficiency is part of ExxonMobil's mission to meet the world's growing need for energy while minimizing environmental impacts.

The researchers on the technology as written in *Science* include Lively and Dong-Yeun Koh from Georgia Institute of Technology and McCool and Harry Deckman from ExxonMobil.

About ExxonMobil

ExxonMobil, the largest publicly traded international oil and gas company, uses technology and innovation to help meet the world's growing energy needs. We hold an industry-leading inventory of resources and are one of the largest integrated refiners, marketers of petroleum products and chemical manufacturers. For more information, visit www.exxonmobil.com or follow us on Twitter www.twitter.com/exxonmobil.

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The Georgia Institute of Technology, located in Atlanta, Georgia, is a leading research university committed to improving the human condition through advanced science and technology. As a leading technological university, Georgia Tech has more than 100 centers focused on interdisciplinary research that consistently contribute vital research and innovation to American government, industry, and business. For more information, visit www.gatech.edu.

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